

PART 700
TRAFFIC SIGNALIZATION

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SECTION 701

GENERAL

701.1 DESCRIPTION

This specification is intended to describe the method and construction requirements for the installation of a traffic signal. The installation shall include all poles, bases, cabinets, controllers, cables, conduits, service boxes, junction boxes, wiring, signal heads, detectors and such other miscellaneous parts.

701.2 CONTRACTOR RESPONSIBILITIES

The Contractor shall be responsible to furnish and install all equipment necessary for the complete and satisfactory operation of the traffic signal, whether said equipment is specifically mentioned or not.

The Contractor shall contact any and all local agencies having jurisdiction over such installations and acquire any permits or licenses that may be required. Copies of any permits or licenses shall be supplied to the Engineer prior to beginning any construction or installation. The Contractor shall comply with all local ordinances, National Electrical Code, and applicable building codes.

The Contractor shall have a licensed journeyman electrician on site while traffic installation work is performed.

The Contractor shall notify the appropriate power company prior to any service connection or attachment to determine the proper type and method of hook-up or installation. The cost of any initial hook-up charge shall be borne by the contractor. This shall include, but not be limited to, the cost of power supplied for all testing until the signal installation is accepted.

The Contractor shall arrange for the supplier of the major items of electronic equipment to have a representative at the site during signal turn-on. Energizing of signal (turn-on) to occur Monday - Thursday, 9:00 AM - 3:00 PM.

The Contractor shall notify any utility companies which may have facilities in the work area. All costs of utility relocation shall be borne by the owner. Adjustments in elevation of service boxes shall be the responsibility of the contractor.

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SECTION 702

MATERIALS

702.1 GENERAL

In so far as practicable, major items of electronic equipment, such as the traffic signal controller and loop detector amplifiers provided and installed under this contract, shall be one type and consist of products of the same supplier in order to secure uniformity, single responsibility, and most satisfactory service.

702.2 TYPE 170 TRAFFIC SIGNAL CONTROLLER SYSTEM

Each Type 170 Traffic Signal Controller System shall meet the applicable specifications detailed in FHWA-IP-78-16 "Type 170 Traffic Signal Controller System - Hardware Specifications" as well as the additional requirements noted below:

Controller Unit:

The Model 170E controller unit shall contain a single MPU with at least 2K of RAM memory on a separate board apart from the Input/Output logic board.

Output interface - The output interface shall consist of a minimum of 80 bits of buffered storage. Output data shall be latched at the time of writing from the MPU. This interface shall provide an NPN open collector output capable of driving up to 40 volts DC and sinking up to 100 milliamperes. A logic state one from the MPU shall be presented as a grounded collector (0 to 2 volts), and a logic state zero presented as an open circuit. Once a port is written into, the data will remain present and stable until either another port is written into it, or until the power is turned off. The state of these output ports at the time of power up or power down shall be an open circuit.

Provide adjustable AC threshold voltage indicator on power supply. All IC's integral to controller unit shall be socket mounted.

IC socket to be low profile, XY stackable with open ladder construction. Socket to contain machines contact with four (4) finger inner contact of machines beryllium copper with gold over nickel plating.

The Model 170E controller shall include a Model 412B2 System memory module of same manufacturer as specified in Traffic Signal Control Equipment Specifications published by the California Business, Transportation and Housing Agency, Department of Transportation (Caltrans), January, 1989 edition. The specifications are available from the Caltrans Publication Unit, telephone (916) 445-3520. The Model 412 System Memory Module shall include lithium cell for backup power to retain data in the volatile RAM devices. The lithium cell shall be replaceable and switched to disconnect cell while module is not in use. Switch to be accessible without removing system memory module. The Model 412 System Memory Module to be provided with WAPITI Micro Systems W4IKS Program (latest revision) on 27256 EPROM.

Conflict Monitor:

General Specifications - The Model 210 conflict monitor(s) supplied shall meet requirements outlined in Chapter 3 of the Traffic Signal Control Hardware Specifications detailed in FHWA-IP-78-16 published by the Federal Highway Administration and dated December, 1978, and the following requirements:

- a) Any dark signal head (that is, loss of signal output to field terminals) shall cause the monitor to trip.
- b) Any yellow time less than 2.8 seconds shall cause the monitor to trip.
- c) The green, yellow and red indications for each phase shall be brought into the monitor individually and shall be monitored separately with respect to a loss of signal on any of the three inputs per channel.
- d) The monitor shall have the required circuitry to allow the early detection of a conflict caused by a green or yellow signal "hang up" (that is, any green or yellow output which shall remain on when the controller has transferred to a yellow or all red output) by starting the fault timers as soon as yellow appears with the corresponding green still energized. The monitor shall not wait until a conflicting green is displayed to time the conflict. This shall preclude the presentation of a conflicting signal display at the intersection.
- e) During the "all red" clearance period (if used), the monitor shall check all inputs for faulty signal display and shall react to these faulty indications during the all red clearance period.

Since during this period the only inputs that should be active would be the reds, the monitor shall detect any faults such as red/green, red/ yellow, green/yellow and green/red/yellow.

The monitor shall be capable of monitoring for incorrect signals applied at the field terminals of each vehicular movement (green, yellow, red). Should a voltage be present on more than one, or none, of the inputs (green, yellow, red) of a channel, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for 700 milliseconds or more, but less than 1,000 milliseconds, the unit may or may not trigger.

- f) When the unit triggers, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control, or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output.
- g) The minimum indicators shall be as follows:
 1. Power - shall be illuminated when the 24VDC input from the controller is present and the AC+ is applied to the monitor.
 2. Watch Dog Error - shall illuminate when the monitor detects a watch dog error.
 3. Conflict - shall illuminate when a conflict has been detected by the monitor.
 4. Red Failure - shall illuminate when a red failure has been detected by the monitor.
 5. Switch Fail - shall illuminate when a faulty load switch has been detected by the monitor.
 6. PCA - shall illuminate when the program board is not installed or is not installed properly.
 7. PIAF - shall illuminate when the unit has detected a failure and then experiences a power interruption.
 8. The monitor shall include signal status indicators. These indications (one per channel) shall illuminate when a proceed signal is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status shall lock up, displaying the status of each channel at the time the conflict occurred. Should the monitor trip due to the absence of red or a faulty load switch output, the signal status indicators shall display the channel (channels) which is (are) at fault.
 9. Yellow - shall illuminate when a short yellow time has been detected.

- h) If the monitor detects a load switch fault condition, the switch failure indicator shall be illuminated and the signal status indicators will display the exact channel of the load switch that failed.
- i) The monitor shall have the ability to view previous faults without interrupting monitor operations.
- j) The monitor shall retain the current fault and the previous two faults which may be displayed individually.
- k) The red inputs shall be brought into the monitor via a front panel connector.
- l) The Red Enable shall be brought into the monitor via the same front panel connector as the red inputs.
- m) A Red Interface Adapter shall be wired in and tested. Red interface block to be programmable without the use of tools or the lowering of any access panels.
- n) Conflict monitor to be capable of monitoring four (4) red, yellow and green outputs from the Model 420 auxiliary output file.
- o) Communications software shall be compatible with W41KS software.
- p) All electrical components used in the signal monitor shall be rated by the component manufacturer to operate beyond the full unit operating temperature range of -34°C to +74°C.
- q) User-programmed configuration settings shall be selected using PCB mounted switches or jumpers. These settings which are transferred to memory shall be stored in a programmable read-only memory (PROM).

Monitor Unit:

Supplemental Specifications - The Model 210 monitor unit is a self-contained compact device which shall be capable of detecting conflicting signal indications. The method of conflict monitoring shall be based upon a design that shall render a reliable detection when one or more of the following are sensed:

- a) Conflicting field output voltages
- b) Threshold power supply voltage below specified
- c) A watchdog timer error

The Model 210 monitor unit shall be capable of monitoring sixteen field signal output circuits at the field terminals.

Functional Requirements -

- a) All monitored field output alternating current voltages shall be measured as either average responding or true RMS responsive to both positive and negative halves of the sine wave.
- b) The conflict monitoring circuitry shall sense voltages greater than 25 volts alternating current with a duration of 500 milliseconds or longer. The conflict monitoring circuitry shall not sense voltages less than 15 volts alternating current or any voltage having a duration of less than 200 milliseconds.

- c) The conflict monitoring circuitry may or may not detect a conflict when the voltage is greater than 15 volts but less than 25 volts and the duration is greater than 200 milliseconds but less than 500 milliseconds.
- d) The conflict monitoring circuitry shall be capable of detecting both a positive and negative half-wave failure under the foregoing conditions.
- e) The monitor unit shall trigger when the watchdog circuit has failed to receive a change in state from the controller unit for 1 second ± 10 percent. The controller unit will change its output to the watchdog timer once every 100 milliseconds.
- f) The monitor unit shall sense the cabinet power supply +24 VDC. It shall consider voltages as low as 22 VDC acceptable, but voltages below 18 VDC shall trigger the monitor. Voltages between +22 VDC and +18 VDC may or may not trigger the monitor. Voltages below monitor thresholds with a duration less than 200 milliseconds shall not trigger the monitor.
- g) When the monitor unit is triggered, the following sequence of events shall occur:
 - 1. An output contact shall close. This shall cause an automatic switching of the field signals from normal operation to flashing operation.

 A power failure shall not result in resetting the monitor unit. The monitor unit upon detection of a conflict shall remain triggered until reset by a front panel control. The output relay shall be electro-mechanical.
 - a. The output relay contacts shall be rated for a minimum of 3 amperes at 120 VAC. The output shall be electrically isolated from ground with a rating of 2000 VDC or better, and 1000 million ohms. Opening and closing time of the contacts shall not exceed 30 milliseconds.
 - b. The stop timing output shall be an NPN open collector which, when triggered, shall be capable of sinking 50 milliamperes at 30 volts. This output shall be compatible with the appropriate input in the Controller Unit. The output shall have a blocking diode installed to prevent it from sourcing power into the controller unit input.
 - 2. The monitor shall store and display the conflicting indications existing at the moment of conflict. These indications, 16 indicators, shall be mounted on the front panel. The monitor shall retain this display until reset by a front panel pushbutton, or upon the loss of power.
 - 3. When the monitor is triggered as a result of sensing a watchdog timing error, it shall illuminate a front panel indicator light labeled "Watchdog Error". The monitor shall retain this condition until reset by a front panel push-button or the loss of power. An internal watchdog muzzle switch shall be provided to inhibit triggering of monitor due to watchdog timer. Power failures of duration of 50 milliseconds or greater shall not cause the timer to trip.

4. When the monitor unit is triggered as the result of sensing a voltage error, it shall extinguish a front panel indicator light labeled "Power". The "Power" indicator light shall remain extinguished until the +24 DC supply is restored.

The monitor module shall be equipped with a programming card. The programming card shall be a printed circuit board 1/16 inch thick and shall plug into the module through a slot in the front panel. A programming card shall be supplied with a full complement of diodes #IN4148, or equivalent. Each programming card shall contain 120 diodes. The programming card shall be logically labeled and laid out for easy identification of the diodes by switch pack.

All switch pack signals being monitored shall be in conflict with all other switch pack signals being monitored, unless a diode (anode to numerical pins and cathode to alphabetical pins) has been removed. Removal of a diode shall define a non-conflict. Example: a diode removed from between Pins 4 and B indicates the signals from Switch Pack 5 are not in conflict with the signals from Switch Pack 2. In addition, the yellow signals from all switch packs shall be monitored unless a jumper is placed between the appropriate yellow switch pack pin and yellow inhibit common on the programming card. Green and yellow output signals from the switch packs shall be "OR'd" together.

5. The programming card shall be 6 inches in depth and 5.15 inches to 5.30 inches in height, and shall intermate with a 28/56 pin double sided connector having bifurcated contacts on 0.156-inch centers. The printed circuit board shall bisect its edge board fingers at their centers to within ± 0.016 inch. The center of the edge board fingers shall be 2.6375 inches from either edge of the board.

This card when installed shall be provided with card ejectors (Stanford Applied Engineering type 6100 or equivalent) for removal from the front panel. This programming card shall be flush with the front panel and slide smoothly on its tracks while being inserted into or removed from the monitor module.

a. Programming Card Connector Wiring

| <u>PIN</u> | <u>FUNCTION (Circuit Side)</u> | <u>PIN</u> | <u>FUNCTION (Component Side)</u> |
|------------|--------------------------------|------------|----------------------------------|
| 1 | Channel #2 Green | A | Channel #1 Green |
| 2 | Channel #3 Green | B | Channel #2 Green |
| 3 | Channel #4 Green | C | Channel #3 Green |
| 4 | Channel #5 Green | D | Channel #4 Green |
| 5 | Channel #6 Green | E | Channel #5 Green |
| 6 | Channel #7 Green | F | Channel #6 Green |
| 7 | Channel #8 Green | H | Channel #7 Green |
| 8 | Channel #9 Green | J | Channel #8 Green |
| 9 | Channel #10 Green | K | Channel #9 Green |
| 10 | Channel #11 Green | L | Channel #10 Green |
| 11 | Channel #12 Green | M | Channel #11 Green |
| 12 | Channel #13 Green | N | Channel #12 Green |
| 13 | Channel #14 Green | P | Channel #13 Green |
| 14 | Channel #15 Green | R | Channel #14 Green |
| 15 | Channel #16 Green | S | Channel #15 Green |
| 16 | DC GROUND | T | CONFLICT |
| 17 | Channel #1 Yellow | U | Channel #9 Yellow |
| 18 | Channel #2 Yellow | V | Channel #10 Yellow |

| | | | |
|-------|-----------------------|-------|--------------------|
| 19 | Channel #3 Yellow | W | Channel #11 Yellow |
| 20 | Channel #4 Yellow | X | Channel #12 Yellow |
| 21 | Channel #5 Yellow | Y | Channel #13 Yellow |
| 22 | Channel #6 Yellow | Z | Channel #14 Yellow |
| 23 | Channel #7 Yellow | AA | Channel #15 Yellow |
| 24 | Channel #8 Yellow | BB | Channel #16 Yellow |
| <hr/> | | <hr/> | |
| 25 | N.C. | CC | N.C. |
| 26 | N.C. | DD | N.C. |
| 27 | N.C. | EE | N.C. |
| 28 | Yellow Inhibit Common | FF | N.C. |

____ Mating connector shall be keyed between pins 24 and 25 and also between BB and CC.

- b. Pin T of the program card called "CONFLICT" shall cause the monitor to trigger when permitted to float, and be inhibited when grounded to Pin 16. All program cards shall have a jumper between Pins 16 and T.

The monitor, when connected to the switch pack output circuit, shall provide protection against conflicting signals resulting from controller unit failure, switch pack failure, short circuited field wiring, etc.

Electrical Requirements - The front panel shall be wired to earth ground.

The conflict monitor shall not trigger when sensing radio frequency energy with a frequency of 10 MegaHertz or greater and an average power of 100 milliWatts or less.

All 120 VAC field terminal inputs shall provide an input impedance of 150 \pm 50K OHMS and be terminated with a discrete resistor having a power dissipation rating of 0.5 watts or greater. Each 120 VAC field terminal input shall be sensed by a separate precision voltage comparator device.

Mechanical Requirements - The dimensions of the monitor module shall be as shown on the plans.

A handle shall be attached to the front panel, and shall protrude no further than 1-1/4 inches from the face of the front panel.

The overall dimensions of the monitor module shall be between 9.75 inches and 9.85 inches from the face of the front panel to the panel surface holding the front mating connector. The module shall be no wider than 1.38 inches. The printed circuit card shall be 1/16 inch thick. The module shall intermate with a 28/56 pin double-sided connector having bifurcated contacts on 0.156-inch centers. The printed circuit board connector shall bisect its edge board fingers at their centers to within \pm 1/64 of an inch. The center of the edge board fingers shall be 4.65 inches from either edge of the board. The center line of the 1/16-inch printed circuit card shall be 0.20-inch (\pm 1/64- inch) from the left edge of the front panel (Front View).

Connector Requirements - All electrical connections into or out of the monitor module shall be through a printed circuit connector, having two rows of 28/56 inch independent bifurcated contacts on 0.156-inch centers, and shall intermate with that portion of the printed circuit card which is 4.5 inches wide.

Monitor Unit Connector Wiring Assignment - Signal Input-Output Connector

| PIN | FUNCTION | | LEVEL TO OPERATE | VOLTAGE | | CURRENT MAX |
|-----|---------------------------------|--------|---------------------|-----------------|-------|----------------|
| | | | | MAX | MIN | |
| 1 | Channel 2 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 2 | Channel 13 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 3 | Channel 6 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 4 | Channel 4 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 5 | Channel 14 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 6 | Channel 8 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 7 | Channel 5 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 8 | Channel 13 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 9 | Channel 1 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 10 | Channel 7 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 11 | Channel 14 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 12 | Channel 3 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 13 | Channel 9 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| 14 | Not Assigned | | | | | |
| 15 | Channel 11 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 16 | Channel 9 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 17 | Not Assigned | | | | | |
| 18 | Channel 12 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| 19 | Not Assigned | | | | | |
| 20 | Chassis Ground | | | | | |
| 21 | AC | | | | | |
| 22 | Watchdog Timer DC Ground | | | | | |
| 23 | +24V DC | | +24V DC | +26V DC +22V DC | | |
| 24 | Pins 24 and 25 Tied Together | | | | | |
| 25 | | | | | | |
| 26 | Not Assigned | | | | | |
| 27 | Not Assigned | | | | | |
| 28 | Output SW, Side #1 | | | | | |
| — | Slotted for Keying | | | | | |

Note: Pins 24 and AA are shorted. Maximum current requirement shall be 500 MA
Monitor Unit Connector Wiring Assignment - Signal Input/Output Connector

| PIN | FUNCTION | | LEVEL TO OPERATE | VOLTAGE | | CURRENT MAX |
|-----|------------|--------|---------------------|---------|-------|----------------|
| | | | | MAX | MIN | |
| A | Channel 2 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| B | Channel 6 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| C | Channel 15 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| D | Channel 4 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| E | Channel 8 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| F | Channel 16 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| H | Channel 5 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| J | Channel 1 | Green | 120VAC | 135VAC | 25VAC | 15MA |

| | | | | | | |
|------------|--------------------|-----------|-------------------------|--------------------|------------|--------------------|
| K | Channel 15 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| L | Channel 7 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| <u>PIN</u> | <u>FUNCTION</u> | | <u>LEVEL TO OPERATE</u> | <u>VOLTAGE MAX</u> | <u>MIN</u> | <u>CURRENT MAX</u> |
| M | Channel 3 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| N | Channel 16 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| P | Not Assigned | | | | | |
| R | Channel 10 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| S | Channel 11 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| T | Not Assigned | | | | | |
| <u>U</u> | Channel 10 | Yellow | 120VAC | 135VAC | 25VAC | 15MA |
| <u>V</u> | Channel 12 | Green | 120VAC | 135VAC | 25VAC | 15MA |
| W | Not Assigned | | | | | |
| X | Not Assigned | | | | | |
| Y | DC Ground | | DC Ground | | | |
| Z | External Reset | DC Ground | | | | |
| AA | +24VDC | | +24VDC | +26VDC | +22VDC | 500MA |
| BB | Stop Time | | DC Ground | | | |
| CC | Not Assigned | | | | | |
| DD | Not Assigned | | | | | |
| EE | Output SW, Side #2 | | | | | |
| FF | AC+ | 120VAC | 135VAC | 95VAC | | |
| — | Slotted for Keying | | | | | |

Detectors:

The Model 222 Two-Channel Loop Detector as specified in Chapter 4 FHWA- IP-78-16 shall provide for a "failsafe" continuous output in response to an open loop or open lead-in wire.

Each detector unit shall provide interface capability with 22 and 44 pin 170 type input file.

Each detector unit shall provide sixteen sensitivity settings via thumb-wheel switches.

Each detector unit shall be provided with a test switch position to verify loop system integrity. The open loop test position shall indicate a previous fault via the front panel indicator. The memory shall remain intact and can be queried repeatedly. Existing detections shall not be reset and the memory shall only be reset by removing and reinserting the detector unit.

Each detector unit to have 60 Hertz filter to reduce power line noise.

Each detector unit shall provide for selection of delay time of 0 to 30 seconds in 2.0 second increments and/or extension time of 0 to 7-1/2 seconds in 0.5 second increments or off if no timing is desired.

Each timer (delay and extension) shall be provided with buffer circuitry to enable or disable the timer based on an external signal output. Each channel shall include an external input to gate the timing. Provide for cross-talk elimination with only one channel on at a time while scanning.

Each detector unit to provide traffic count capability via serial interface.

Controller Cabinet:

The Model 332B Cabinet and Model 336A Cabinet cabinets shall meet the applicable specifications detailed in the Caltrans Specifications* as well as additional requirements that follow. The cabinets shall be unpainted natural aluminum. The output file must be capable of flashing all 8 phases red or yellow. The three-point locking mechanism shall be fabricated so that it may be actuated by rotating a removable 5/8 inch hex key. The hex socket and locking cam shall rotate on a 3/4 inch minimum diameter shaft.

The socket and shaft shall be field-replaceable with common tools. The socket head shall be protected from being rotated with a pipe wrench or similar tool. One aluminum hex wrench shall be provided with each cabinet.

The cabinet assembly shall be provided with a Power Distribution Assembly (PDA) number 2 and the circuit option (Section 6.4.3.9 of the Caltrans Specifications*).

All #8 conductors from service panel (TBS) and mercury contactor to signal bus and main equipment bus shall be 133 strand #29 AWG electronic hook-up wire.

A hybrid power line surge protection device such as the EDCO Surrrestor SHA-1210 or equal shall be furnished in each controller cabinet. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effects of transient voltages applied to the AC line. The protector shall be mounted inside the PDA#2. The Equipment Line Out shall provide filtered power to the controller, 24 VDC power supply, input file and conflict monitor through shielded cable or twisted pair to the units AC plus and AC minus inputs.

The protector shall include the following features and functions:

Maximum AC line voltage: 140 VAC.

Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20,000 Amperes.

The protector shall be provided with the following terminals:

- Main line (AC Line first stage terminal).
- Main Neutral (AC Neutral input terminals).
- Equipment Line Out (AC Line second stage output terminal, 10 Amps.).
- Equipment Neutral Out (Neutral terminal to protected equipment).
- The Main AC line in and the Equipment Line out terminals shall be separated by a 200 Microhenry (minimum) inductor rated to handle 10 Amp AC Service.
- The first stage clamp shall be between Main Line and Ground terminals.
- The second stage clamp shall be between Equipment Line Out and Equipment Neutral.

Each cabinet shall be furnished with a communications terminal block, C2P harness and connector, voice jack harness, and voice jack, conforming to the requirements detailed in the Caltrans Specifications*.

*Traffic Signal Control Equipment Specifications, published by the California Business, Transportation and Housing Agency, Department of Transportation (Caltrans), January 1989 Edition.

TBO/Communications Termination Block - This terminal block will serve as the termination block for the communication conductors, overvoltage protection devices, and the termination points for the C2P harness and conductors. Install over voltage protection ground bus and hard wire to equipment ground bus with #8 AWG wire.

C2P Harness and Connector - A four-conductor, jacketed cable shall be attached to the terminal block with locking spade lugs. The cable shall terminate in a standard C2P connector and shall be routed through the cabinet and be of sufficient length to reach the C2S connector on the back of the 170 controller unit when the unit is installed in the equipment rack.

Voice Jack Harness - A two-conductor twisted, jacketed cable shall be attached to the terminal block with locking spade lugs. The cable shall be routed to the voice jack.

Voice Jack - A voice communications jack shall be installed with solder lugs extending out of the side of the jack housing and shall have a cover.

Each terminal on output terminal blocks to be marked as per phase function.

Jumper I 13-K to I 13-E to I 12-E to I 12-K to I 16-2.

Provide Fiberglas disposable filters in lieu of metal filters.

The input file printed circuit board must be accessible without removing or lowering panel.

Provide 44-pin serial input file.

The lifting eyes shall be removable.

Interchangeability of the Isolation Relay and Logic Relay shall not be possible.

Flash blocks to be accessible without lowering or opening any service panels and marked as per phase.

Red interface adapter to be programmable without tools.

Red interface adapter to be accessible without lowering or opening access panels.

Provide cable tie down (Richo #CFC C-8) or equivalent to secure red interface adapter cable to the bottom of the output file.

Anchor bolts to be provided with 332B Cabinet.

Additional Model 336A Cabinet Specifications:

The cabinet shall be a weatherproof, outdoor, pole-mounted or pedestal-mounted type with overall dimensions not to exceed 38 inches high by 22 inches wide by 20 inches deep. The cabinet will utilize all the standard plug-in modules that are utilized by the Type 336 Caltrans cabinets.

The bottom of all 336A cabinets shall be solid plate and be reinforced with a 20" x 22" 0.375 aluminum base plate continuously welded to the inside bottom of the cabinet.

Cabinets shall be attached to the pole using two aluminum mounting brackets, mounted top and bottom, for each cabinet. The brackets shall be secured to the cabinets using appropriate stainless steel mounting bolts and washers. The brackets shall be secured to the pole by appropriate banding buckles and couplings.

Door opening flange around the door opening shall be 0.75 inches wide.

Steel rails shall be provided in lieu of the rack cage for mounting of the controller and cabinet assemblies. The rail assembly shall consist of 4 EIA threaded rails bolted to the two sides at the front and rear of the cabinet. The rails shall be threaded in the same manner and pattern as the Model 332 cabinet cage. The rails shall be plated as specified in Caltrans Specifications*, Section 1.2.8.3.2.

The cabinet, if used for school signal control, shall be modified to operate flashing beacons by time-of-day, day-of-week through controller output.

Switch Pack:

The components of the three solid state switches, enclosed in the load switch, shall be of interchangeable, modular cube design.

Cube to be mounted separate from circuit board for ease of replacement.

Housing and handle to be constructed of metal, suitably protected against corrosion.

Flasher Unit:

Each of the two load circuits contained in the Flasher Unit shall be of separate interchangeable cube design.

Cubes are to be mounted separate from circuit board for ease of replacement.

Housing and handle to be constructed of metal, suitably protected against corrosion.

Zonal Master Controllers:

The zonal master controller shall conform to the Type 170 specifications.

Insofar as possible, the boards from the master shall be interchangeable with those in the local 170's.

- a) The zonal master 170's shall be configured with a second serial port. The second serial port shall be the same type as the primary serial port and address mapped to location 6002 (Hex) for control functions and location 6003 (Hex) for data functions. The second serial port shall be capable of operating at a clock rate of 300, 600, 1200, 2400, 4800, or 9600 baud. This selection shall be independent of the primary ACIA.

The signals from the second ACIA shall be routed to the rear panel of the 170 chassis and terminated in a 14-position connector identical to the C2 connector. This connector shall be marked C20S.

A three-foot cable shall be provided to interconnect from the C20S connector to a standard DB25S connector on an auto dial modem.

- b) All controllers shall be provided with a Model 400 Modem Module as detailed in Chapter 7 of the Caltrans Specifications*.
- c) Each zonal master 170 controller unit shall be supplied with one (1) Model 412B2 System Memory Module. The module shall be provided with WAPITI Micro Systems W70SM, latest revision, software package, on 27256 EPROM.

702.3 TRAFFIC SIGNAL LAMPS

Lamps for vehicular and pedestrian signals shall meet the following requirements.

8" and 9" Signals:

A nominal 60 watt, 120 volt, A19 clear traffic signal lamp of 8,000 hour life rating guaranteed by the manufacturer to be used in all 8" vehicular and 9" pedestrian indications. Lamps shall be 80% Krypton filled with heat reflection.

12" Signals:

A nominal 135 watt, 120 volt, A21 clear traffic signal lamp of 6,000 hour life rating guaranteed by the manufacturer, to be used in all 12" vehicular and pedestrian indications. Lamps shall be 80% Krypton filled with heat reflection.

Candlepower:

All traffic signal lamps must meet beam candlepower specification of ITE-1110(1970).

Mass Spectrometry Analysis:

Mass Spectrometry Analysis to verify percent Krypton shall be provided with catalog cut sheets.

702.4 BACK PLATES

Where shown on the plans, 5" back plates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Back plates shall be constructed of aluminum alloy sheet or durable plastic capable of withstanding a 100 mph wind.

Where a back plate consists of two or more sections, the sections shall be fastened with rivets, stainless steel or aluminum bolts, opened after assembly to prevent loosening.

702.5 ALUMINUM TRAFFIC SIGNAL PEDESTALS

Unless specified on the plans, the following specifications shall govern the design of aluminum traffic signal pedestals:

Shaft:

The shaft shall be a one-piece tube of 6063-T6 aluminum alloy with a minimum wall thickness of 0.237". The shaft shall be of uniform diameter throughout length. The shaft outside diameter at the top shall be approximately 4.5". Overall height of the shaft and base shall be 10 feet. The shaft shall have a satin brush finish. The shaft shall be threaded with a nominal 4" pipe thread and be threaded into the base. The base and shaft are to be drilled and fitted with a 3/8" bolt and nut.

Base:

The base shall be equipped with a handhole and door for access to the interior of the base. The handhole shall have a minimum dimension of 7 3/4" by 8". The door shall be fastened in place by a single bolt which shall have an allenhead to discourage unauthorized personnel from gaining access to the wiring compartment in the pedestal base. The pedestal base shall be mounted to a poured concrete pad by means of four anchor rods set in a bolt circle of 13 1/2" diameter. There shall be a provision in the base for the attachment of a ground wire.

Hardware:

Anchor rods shall be 5/8" diameter by 18" long plated, and shall be supplied with nuts, lock washers and flat washers. The shaft shall be secured to the base by a 3/8" bolt to prevent loosening of the shaft due to vibration, wind, etc.

General:

The pedestal and base shall be designed to withstand a wind load of 100 mph with a 25 percent gust factor while supporting a one-way, three section, 12" aluminum traffic signal head. The shaft shall be wrapped with protective paper for shipment. Large scratches or gouges in the aluminum material shall be cause for rejection.

702.6 AC SERVICE INPUT

Each service disconnect must be furnished with an installed lightning arrest on the AC service input which meets or exceeds the following requirements:

- a) The unit must be capable of withstanding repeated 20,000 ampere surges (minimum of 20).
- b) The unit must have internal follow - current limbers (resistive elements).
- c) The unit must contain three active clamping stages minimum.
- d) The unit must self-extinguish within 8.3 milliseconds after the trailing edge of the surge.
- e) The parallel impedance of limbers must be less than 0.15 OHMS.
- f) The unit shall be UL approved.

Each service disconnect to have 70 AMP main lugs with no more than 4 circuits.

702.7 ELECTRICAL WIRE AND CABLE

All wire and cable supplied under this specification shall be approved based upon catalog cuts submitted to the Engineer. In addition, all wire and cable shall be visually inspected by the Engineer. Any apparent defect that may shorten the service life of the wire or cable shall be cause for rejection.

Shielded Loop Detector lead-in Cable:

Unless otherwise specified, shielded loop detector lead-in cable shall be Beldam 8720 #14 AWG.

The conductor and drain wires, shall be tinned copper wires. The conductors shall be shielded by a layer of aluminum bonded to polyester film. All wires shall have polyethylene insulation and a jacket of vinyl.

In addition, the cable shall meet the following requirements:

| | |
|---------------|-------------------------------|
| 18 | AWG (stranded) drain wire |
| 14 | AWG (stranded) |
| 025 | Insulation thickness (1 inch) |
| 030 | Jacket thickness (1 inch) |
| 274 | Nom. O.D. (1 inch) |
| Black & Clear | Conductor color code |
| 100 | Percent shield coverage |
| 24 | Nom * cap (PF/FT) |
| 47 | Nom ** cap (PF/FT) |
| 600 | Suggested working voltage |

* Capacitance between conductors

** Capacitance between one conductor and the other conductor connected to shield.

Loop Detector Wire:

The loop wire shall be No. 14AWG Stranded Copper with Type THHN or THWN insulation with UL approval and 600v rating.

Multi-Conductor Cable:

Conductor cable for intersection signalization shall be multi-conductor cable of the size specified on the plans for operation on a 600V maximum, and suitable for use at conductor temperatures not exceeding 75° C. Material, construction and tests shall be in accordance with the applicable requirements of the Insulated Cable Engineers Association Standard S-6L-402 "Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".

Conductors shall be stranded, annealed, uncoated copper or annealed, coated copper. Copper wire before insulating or stranding shall meet the requirements of the latest edition of ASTM B-33 (for coated wire) or STM B-3 (for uncoated wire). Stranding shall be Class B, in accordance with the latest edition of STM B-8.

Insulation for the individual conductors shall consist of a 20 mil thickness of polyethylene, and an insulation covering of a polyvinyl chloride compound with a 10 mil thickness.

The polyethylene insulation shall meet the requirements of paragraph 3.9 of ICEA Standard S-61-402 before application to the conductor, and paragraph 3.9.1 after application to the conductor.

The polyvinyl chloride insulation covering shall meet the requirements of paragraph 4.3.1 of ICEA Standard S-61-402, and shall be color coded in accordance with Method 1, Part 5 of ICEA Standard S-61-402.

The overall cable jacket shall consist of a polyvinyl chloride compound which will provide a tough, heat, moisture, ozone, and flame resistant covering meeting the requirements of paragraph 4.3.1. of ICEA Standard S-61-402. The overall jacket thickness shall be in accordance with Table 18, Part 4, ICEA Standard S-61-402.

Conductor cable conforming to the requirements of Specification 19-1 of the International Municipal Signal Association (IMSA) may be used in lieu of above.

Conductor cable used for the signal control circuits shall be #14 AWG multi-conductor cable, meeting the above requirements.

Conductor cable used for intersection communication shall be six pair #19 AWG shielded cable conforming to the requirements of Specification 20-2 of the IMSA. Shielding shall also conform to IMSA Specifications.

Messenger Cable:

The messenger cable used for support of overhead communications and detector lead-in cable shall be fabricated of seven zinc-coated, steel wires, Class A galvanized in accordance with STM A-475, and twisted into a single concentric strand. The tensile strength of the 5/16-inch messenger cable shall equal or exceed 6,000 pounds.

The contractor is to provide certification that the messenger cable has been tested and meets the required tensile strength.

Power Supply Wire:

Intersection signalization power supply wire shall be single conductor wire for operation on a 600V maximum, and suitable for use at conductor temperatures not exceeding 75° C. Material, construction and tests shall be in accordance with the applicable requirements of the ICEA Standard S-66-524 "Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".

Conductors shall be stranded, annealed coated copper. Copper wire before insulating or stranding, shall meet the requirements of the latest edition of ASTM B-33 (for coated wire). Stranding shall be Class B, in accordance with the latest edition of STM B-8.

Refer to drawings for size and type of wire required.

702.8 STEEL MAST ARM TYPE TRAFFIC SIGNAL STANDARDS

The following specifications shall govern the design of steel mast arms with poles and bases unless otherwise specified:

Complete Assembly:

All items for complete assembly shall be furnished including, but not limited to:

- a) Arm with support shaft and base.
- b) Flange plates and bolts for attachment of mast arm to shaft.
- c) Anchor bolts with nuts and washers.
- d) Cover(s) for the exposed anchor bolts.
- e) Caps for top of pole and mast arm end.

Design:

The complete assembly shall be designed in accordance with the loading and allowable stress requirements of the 1985 AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals." Loading shall be based on an isotach wind velocity of 80 mph times a 1.3 gust factor. A Letter of Certification from the manufacturer, and stamped by a registered professional engineer, shall be submitted certifying compliance to these specifications. If requested, calculations and detail drawings shall also be submitted for verification of compliance to these specifications.

- a) **Pole Class 1** - Class 1 poles shall be 20' long and be designed to support rigid mounted signs and signals with the projected areas and weights as shown below:

- b) **Pole Class 2** - Class 2 poles shall be 35' long and be designed to support the same signal and sign loadings as the Class 1 pole plus a 15' truss type luminaire arm, with a luminaire, at a mounting height of 40'. The luminaire shall have 3.2 square feet of projected area and weigh 70 pounds. The arm shall have a 5' upsweep and be connected to the pole by two double bolt simplex castings. The vertical distance between the bolt holes on the simplex castings shall be 27 9/16". The directional alignment of the luminaire arm(s) shall be parallel with the mast arm.

Steel Tubes:

The tubular cross section shall be round and shall have a constant linear taper of 0.14 in./ft. or twelve sided and have a linear taper of 0.10 to 0.18 in./ft. They shall be fabricated from United States produced coil or plate steel conforming to the requirements of ASTM A595 grade A or ASTM A572, having a guaranteed minimum yield strength of 55,000 psi after fabrication. Tubular members 50' in length or less shall be of the same thickness throughout the entire length of the member.

- a) **Mast Arms** - The mast arm shall have a horizontal length as called for on the plans. All mast arms shall be manufactured and shipped in one piece. Two piece mast arms, joined together by a slip over joint, will not be acceptable. A wiring grommet for 1.50" through holes shall be provided for each signal head, internally illuminated street name sign or other required fixture.
- b) **Pole Shafts** - 4" x 6.5" hand hole shall be welded into the shaft at 1.5' from the base of the pole and located 180 degrees from the mast arm. A cover shall be provided for the hand hole. Pole top caps shall be provided and shall be secured in place with set screws or other suitable fasteners. A "J-hook" wire support and grounding attachment shall be provided in each pole shaft.

Anchor Bolts:

Anchor bolt material shall have a minimum yield strength of 55,000 psi and the bolts shall be galvanized to ASTM A153 for a minimum of 8" on the threaded end. Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the bolts. The anchor bolt sizes are to be standardized as follows:

1. Mast arm lengths 16' through 38'
4 - 1.50" Dia. x 54" long x 6" hook Bolt Circle = 16"
2. Mast arm lengths 39' through 55'
4 - 1.75" Dia. x 84" long x 6" hook Bolt Circle = 20"

Base Plate:

The base plate shall be of the steel meeting or exceeding the requirements of ASTM A 36. It shall be integrally welded to the pole shaft with either a telescopic welded joint or a full penetration butt weld with a backup bar.

Mast Arm Attachment:

Arm and pole mounting plates shall be provided. The mast arm plate shall telescope the mast arm and be circumferentially welded inside and out. The pole plate shall be attached to the pole shaft by welded gusset plates at the top, bottom and sides. Four high strength bolts with nuts meeting ASTM A-325 shall be furnished for the arm to pole attachment. Smooth holes shall be provided in the two plates to allow the signal cable to go from the pole to the arm without exposure to the outside weather. Tapped holes to have bolts installed completely.

Identification:

The manufacturer shall permanently mark each mast arm and pole to identify them with their corresponding Traffic Signal Pole Summary item number. All hardware is to be packed on a per

pole basis.

Galvanizing:

The traffic signal pole and arm shall be galvanized in accordance to ASTM A123. Each component must be completely coated in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.

Welding:

Welding shall be in accordance with American Welding Society (AWS) Structure Welding Code D1-1 Sections 1 through 6 and shall be performed by welders certified in accordance with the AWS Code. The tube's longitudinal seam welds shall be free of cracks and undercutting, performed with automatic processes, and visually inspected with questionable areas inspected by magnetic particle to AWS D1.1.

Material Certifications:

All materials and products shall be produced in the United States of America. They shall be of the ASTM type as called forth in this specification. If requested, mill certifications shall be supplied for proof of compliance to this specification.

Fabricator:

Fabricator shall be certified under Category I, "Conventional Steel Structures" as set forth by the American Institute of Steel Construction's Quality Certification Program and have a full-time structural engineer on staff. Proof of this certification will be required prior to bid opening to assure that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality Traffic Signal Pole Structures.

702.9 STEEL SPAN WIRE POLES

The following specifications shall govern the design of steel span wire poles and appurtenances unless otherwise specified:

Complete Assembly:

The complete assembly shall include, but not be limited to:

- a) Tapered steel shaft with base.
- b) Handhole with cover.
- c) Cap for top of pole.
- d) Span wire clamps.
- e) Steel wire entrance (weatherhead).
- f) Anchor bolts with nuts and washers.
- g) Covers for exposed anchor bolts.

Design:

The total assembly shall be designed to support, by means of a span wire and tether, the various equipment listed. The pole shall provide a minimum clearance of seventeen feet (17') from the pole base elevation to the tether wire, with a span wire sag of three one-half to five percent (3 ½ to 5%).

The length of the pole shall be thirty feet (30').

The manufacturer shall provide an information sheet showing design details of the pole, anchor bolts, flange construction. Orientation of anchor bolts, recommendation for back rake, and any other pertinent installation instructions.

Anchor Bolts:

Anchor bolt material shall have a minimum yield strength of 55,000 psi and the bolts shall be galvanized to ASTM A153 for a minimum of 8" on the threaded end. Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the bolts.

Anchor Base:

A one-piece steel anchor base with a sixteen inch (16") or twenty inch (20") bolt circle, exceeding the requirements of ASTM A-36. It shall be integrally welded to the pole shaft with either a telescopic welded joint or a full penetration butt weld with a backup bar.

Pole Shaft:

The shafts shall be fabricated plate steel conforming to regulations of ASTM A-5909 or ASTM A-572 for a guaranteed minimum yield strength of 55,000 psi after fabrication.

A manhole with a minimum area of twenty-five square inches (25") shall be welded into the shaft a short distance from the base. A cover shall be provided for the manhole.

Pole top caps shall be provided and shall be secured in place with set screws or other suitable fasteners.

A "J-hook" wire support shall be provided in each pole shaft.

Provision shall be made for a grounding attachment.

Span wire clamps shall be provided to attach two span wires.

A steel, wire entrance (weatherhead) shall be provided for each pole.

Identification:

The manufacturer shall permanently mark each pole to identify it with the corresponding traffic signal pole summary item number.

Galvanizing:

The traffic signal pole and arm shall be galvanized in accordance to ASTM A-123. Each component must be completely coated in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.

Welding:

Welding shall be in accordance with American Welding Society (AWS) Structure Welding Code D1-1 Sections 1 through 6 and shall be performed by welders certified in accordance with the AWS Code. The tube's longitudinal seam welds shall be free of cracks and undercutting, performed with automatic processes, and visually inspected with questionable areas inspected by magnetic particle to AWS D1.1.

Material Certifications:

All materials and products shall be produced in the United States of America. They shall be of the ASTM type as called forth in this specification. If requested, mill certifications shall be supplied for proof of compliance to this specification.

Fabricator:

Fabricator shall be certified under Category I, "Conventional Steel Structures" as set forth by the American Institute of Steel Construction's Quality Certification Program. Proof of this certification will be required prior to bid opening to assure that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality Traffic Signal Pole Structures.

702.10 EIGHT-INCH AND TWELVE-INCH POLYCARBONATE TRAFFIC SIGNAL HEADS

These specifications are intended to provide the minimum requirements for polycarbonate traffic signals that will be acceptable.

- a) The housing shall be screw-injection molded polycarbonate resin and shall be of sectional construction to permit the installation of additional sections for future needs.
- b) The doors shall be screw-injection molded polycarbonate resin which shall be hinged at the left side and with substantial screw or wingnut-type fasteners of stainless steel at the right side. Cam-type fasteners will not be permitted. The visor shall be of polycarbonate resin.
- c) All housings and doors shall be interchangeable.
- d) The lenses shall be gasketed to exclude dust and moisture. The lens, reflector, socket and gasketing must make a waterproof assembly.
- e) The housing shall be yellow with signal doors and visors a flat black. No painting shall be permitted. Color must be molded completely through the polycarbonate material and shall not require painting in future years.
- f) The lenses shall be 8 3/8" or 12" diameter; the exterior or convex surface shall be smooth. The lenses shall be unlettered red, yellow, green and green arrow when required and shall conform to the specifications of the Institute of Traffic Engineers. Lenses must be of polycarbonate material.
- g) "ALZAK" aluminum reflectors meeting the specifications of the Institute of Traffic Engineers shall be furnished. Only high-purity aluminum shall be used. Scratches or dullness of reflectors shall be cause for rejection. The reflector shall either be gasketed to the door without additional springs or other type fasteners or it shall be hinged from the section housing. Spring or pressure-type fasteners that require removal prior to changing a bulb are not acceptable.
- h) The lamp receptacle shall conform to the ITE Technical Report Number One and to Supplement to Technical Report Number One of ITE.
- i) The optical unit shall provide for Anti-Sun Phantom.
- j) There shall be a terminal block in each head.
- k) All signals shall be adjustable type.
- l) All gaskets shall be neoprene or rubber.
- m) All signals shall be shipped assembled with visors attached.
- n) The front of each signal section shall be square in appearance to provide maximum "target value".
- o) Each signal section shall have internal reinforcing webs adjacent to the mounting holes or aluminum support plates to provide additional strength and rigidity. The support plates shall be approximately the same size and shape as the signal cross-section and shall be provided for span wire mounting. The two support plates shall be provided outside, one on top of the top section and one on the bottom of the bottom section. One support plate shall be provided inside the top section at the top and one support plate shall be provided inside the bottom section at the bottom.
- p) Depending on the type of mounting specified, all signals shall be provided with signal closures. Example: Eagle's pinnacle assembly or Crouse-Hinds rosette cap with locknut. If no brackets are called for, end closures shall not be provided.

- q) Each box shall be marked to indicate the type of mounting the signal is intended for and the bid item number.
- r) A blank signal section shall consist of housing, door and both lens and door gaskets.

702.11 POLYCARBONATE PEDESTRIAN SIGNAL HEAD

These specifications are intended to provide the minimum requirements for polycarbonate pedestrian signals that will be acceptable.

- a) A pedestrian signal shall consist of two identical sections, one to indicate **WALK** and the other to indicate **DON'T WALK** when illuminated by a single standard incandescent traffic signal lamp contained in each section. The design of the signal shall be such that the two sections can be held firmly together in a manner that they can be readily disassembled and reassembled for repair or revision.
- b) The housings shall be screw injection molded polycarbonate resin and shall be of sectional construction. The top and bottom of each section shall have serrations molded in to facilitate adjustment and attaching to other sections.
- c) The doors shall be screw injected molded polycarbonate resin and shall be hinged at the left side with substantial screw-type fasteners of stainless steel at the right side. Cam-type fasteners will not be permitted. The visor shall be of polycarbonate resin.
- d) All housings and doors shall be interchangeable.
- e) The housings shall be yellow with signal doors and visors a flat black. No painting shall be permitted. Color shall be molded completely through the polycarbonate material to eliminate any future painting.
- f) Each lens shall be flat with a smooth outside surface. When not illuminated, the lettering on each lens shall be well obscured. The lettering shall be in a straight line with a minimum height of 3" and a 3/8" wide stroke. Lettering style shall conform to ITE standards.
- g) The lenses shall be lettered **DON'T WALK** and **WALK**. **DON'T WALK** lenses shall be Portland Orange in color and **WALK** lenses shall be Lunar White in color. Lenses must be polycarbonate material and shall conform to ITE specifications.
- h) The lenses shall be gasketed to exclude dust and moisture. The lens, reflector, socket and gasketing must make a waterproof assembly.
- i) ALZAK aluminum reflectors meeting the specifications of the ITE shall be furnished. Scratches or dullness of the reflectors shall be cause for rejection.
- j) The lamp receptacle shall conform to ITE standards with the proper size focal length bulb.
- k) Each section shall have a visor (minimum 8") which shall be square in appearance.
- l) All signals shall be adjustable and shall contain a terminal block in each head.
- m) All gaskets shall be neoprene or rubber.
- n) All signals shall be shipped assembled with visors attached.
- o) The optical unit shall provide for Anti-Sun Phantom with the lenses having black opaque backgrounds.
- p) If available, the manufacturer shall supply extra aluminum support plates in the top of the top section when the bid request calls for no brackets and in the bottom of the bottom section when the bid request calls for a one-way post top mount.

702.12 BRACKETS AND MOUNTING ATTACHMENTS

Brackets, clamps, etc. shall be furnished in accordance with the details on the plans and/or items listed in the bill of materials. The contractor shall be responsible to advise the supplier of the exact intent of the plans with regard to proposed signal mounting combinations and their corresponding

signal orientations and signal head types as well as the requirements for other appurtenances, such as cabinets or signs. In this manner, it is intended that all fittings, spacers, bolts, clamps, etc. shall be furnished in sufficient quantity to effect complete mounting of the signal head(s) or other appurtenances whether or not each individual element is delineated or itemized on the plans.

Bracket Assemblies:

Bracket assemblies shall conform to the following provisions unless otherwise noted on the plans:

- a) Construction shall be from malleable iron or aluminum.
- b) Provisions shall be made for accepting and directing wire feeds coming from inside the signal support pole.
- c) All brackets shall be shop painted federal yellow.

Pole Mounting Fittings:

Pole mounting fittings shall be either cast aluminum or cast iron.

Banding Material:

Banding material shall be 3/4" stainless steel with stainless steel buckles of the same size. Sharp ends to be folded under to prevent injury to pedestrians.

702.13 RIGID GALVANIZED STEEL CONDUIT

All conduit shall be hot dipped galvanized rigid steel conduit, UL approved, and meet Federal Specifications WW. C-581-D and/or American Standard #080-1.

702.14 STREET NAME SIGN

General:

This specification covers finished reflectorized street name signs specifically designed to inform a motorist of the identity of a street he/she is approaching.

Material:

Metal Backing - The material shall be .125 gauge, aluminum alloy 6063T6 or aluminum alloy 5052-H38, 18" x 60" with all corners rounded.

- a) **Reflective Sheeting** - Faces fabricated from reflective sheeting shall be in accordance with "Standard Specifications for Construction of Road and Bridges on Federal Highway Projects FP-79 1979 Section 633.06 - Sheet Reflective Materials"; Table V, Type IIIA referred to as high intensity. All legends and borders shall be silver in color while backgrounds shall be green in color.

All signs shall have silver legends and borders on green backgrounds on only one side of the aluminum blank.

- b) **Legend** - All upper case letters shall be 8" series E modified. All lower case letters shall be 8" series E modified.
- c) **Border** - All borders shall be 3/4" wide silver material.

All signs shall have legends centered on face with the letters sized and spaced to produce a readable, professional quality sign.

The finished signs shall be of good appearance, free from ragged edges, cracks, scales or blisters, and the legend shall be clear-cut.

702.15 VEHICLE DETECTOR LOOP WIRE SEALANT

- a) The saw slot filler and encapsulant shall be a one-part polyurethane, moisture curing, elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation and designed specifically for sealing and protecting vehicle detector loop wires installed in sawcuts 1/4" to 3/8" wide and 3 1/2" deep.
- b) The encapsulant is intended to provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in asphaltic and concrete pavements, while protecting the loop wire from moisture penetration, fracture and shear.
- c) The encapsulant shall be designed for roadway installation when surface temperature is between 40 and 140 degrees F and enable vehicular traffic to pass over the sawcut immediately after installation without tracking or stringing of the material. The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 75°F and completely cure to a tough, rubber-like consistency in two (2) to seven (7) days after installation.
- d) Cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, antifreeze solution, brake fluid, deicing chemicals and salt normally encountered, in such a manner that the performance of the vehicle detector loop wire is not adversely affected.
- e) Filling of the sawcut shall be in accordance with the directions of the manufacturer.

702.16 NUTS AND BOLTS

When used in mast arm attachments to the pole or in anchoring the pole to the concrete base, the nuts and bolts shall be rated high strength meeting ASTM A-325 and conform to Section 1613, Type II of the 1988 KDOT Standard Specifications. An anti-seize compound shall be used on all bolts, screws, etc.

702.17 PEDESTRIAN PUSHBUTTON ASSEMBLY

This specification is intended to provide minimum requirements for pedestrian pushbuttons that will be acceptable:

- a) A one-piece cast aluminum raised sign legend with pushbutton housing.
- b) Weatherproof and dustproof pedestrian pushbutton with silver contacts rated a minimum of 35 amps at 12 volts.
- c) The legend "Push Button - Wait For Walk Signal" shall be cast into the face of the assembly.
- d) Assembly to have 4" radius bracket mount for banding to pole.

702.18 CRUSHED ROCK

Crushed rock used in bottom of service boxes and junction boxes shall meet ASTM C33, latest revision, size #67, 3/4" to #4. Rock quality to conform to quality specified in standard specifications for asphalt mixtures.

702.19 AERIAL SPLICE BOX

The contractor shall furnish and install aerial enclosures for splicing overhead interconnect cable. Spliced enclosures shall be of polyethylene construction and be capable of accommodating up to a 12-pair cable. The enclosure shall provide easy access to aerial cable, while providing weather protection for the splice. No aerial splice boxes shall be installed at locations that cannot be accessed by a maintenance truck, or that require the climbing of a pole for service.

The enclosure shall have the following overall maximum exterior dimensions: 30 inches long, 10 inches high, and 4 inches wide. Minimum dimensions of 16 inches long, 6 inches high, and 3.5 inches wide shall be provided for the interior compartment.

The enclosure cover shall be capable of easy removal for splicing the interconnect cable and easily stored for typical maintenance activity, such as replacement of interior termination blocks or cable diagnostics.

All communication cable conductors shall be accommodated on termination blocks provided within the enclosure. The aerial enclosure shall be capable of being installed while enclosing the overhead supporting messenger strand. Once installed, the enclosed messenger strand and interconnect cable shall appear as one unit under the splice cover.

Bonding and Grounding of the splice enclosure shall be accomplished through attachment to the messenger support strand.

Cable binding posts shall be configured to allow up to three-wire conductors each.

702.20 CONDUIT

Steel:

Conduit shall meet the requirements of Federal Specification WW.C-581-D or American Standard 081-1 for Rigid Galvanized Steel Conduit.

Plastic:

Conduit shall be a minimum of Schedule 40 Polyvinyl Chloride (PVC) pipe.

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SECTION 703

CONDUIT

703.1 GENERAL

All conductors shall be run between bases, junction boxes pull boxes, and services boxes in rigid conduit. The size of the conduit used shall be of the size as shown on the plans.

703.2 JOINTS AND BENDS

The ends of all conduit shall be well reamed to removes burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union shall be used. The threads on all conduit shall be painted with a good quality of lead or rust preventative paint before couplings are made. All couplings shall be fitted and tightened until the end of the conduits are brought together. Where coating on conduit has been injured in handling, or installing, such injured places shall be thoroughly painted with rust preventative paint.

All conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

The location of ends of all conduit for future electrical circuits in structures shall be marked by a "Y" at least three inches (3") high cut into the face of curb, sidewalk, gutter or wall directly above the conduit.

Conduit bends, except factory bends, shall have a radius of not less than six (6) times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable.

703.3 INSTALLATION

Conduit set in bases shall extend two to three inches (2" to 3") vertically from the top of the base. A plastic or metal conduit bushing shall be installed on the end of all conduit terminating within a base. Conduit shall enter through the sides of a pull box and shall leave the major portion of the box clear. Conduit entering concrete service and junction boxes shall not extend more than 5" inside of service or junction box as measured along the longitudinal axis of the conduit. Conduit entering service boxes shall be at least six inches (6") above the crushed rock bottom of the service hole. Conduit should be sloped to drain as directed by the Engineer. At all outlets, conduits shall enter from the direction of the run.

Wherever possible, the conduit shall be installed by trenching. Trenches shall run in straight lines between pull boxes and bases. The location of the conduit shall be as shown on the plans, except that where physical obstructions dictate, the location shall be determined by the Engineer. Conduit shall be installed to a depth of at least thirty inches (30") below finish grade. This requirement may be waived by the Engineer where physical conditions or obstructions warrant.

Trenches shall be backfilled with material free of rock and compacted in lifts by hand tamping or with mechanical tampers to the density noted on the plans. If a density is not specified on the plans, trench backfill shall be compacted until, in the opinion of the Engineer, no significant future settlement will occur.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressor air.

Conduit runs shown on the plans are for bidding purposes only, and may be changed with permission of the Engineer to avoid underground obstructions.

Conduit placed under existing pavement or sidewalk shall be installed by an approved jacking or drilling method. The existing pavement shall not be disturbed unless otherwise noted on the plans or approved by the Engineer. Excessive use of water such that the pavement might be undermined, or the subgrade softened, will not be permitted.

SECTION 704

CONCRETE BASE FOR POLES AND CONTROLLER CABINET

704.1 GENERAL

Bases for poles and cabinets shall be reinforced concrete and as shown on the detail sheets.

Material requirements for the concrete and reinforcing steel shall be in accordance with subsection 406.3

704.2 CONSTRUCTION REQUIREMENTS

Anchor bolts shall be of the size and design recommended by the manufacturer of the particular pole to be installed. They shall extend uniformly above the finish grade of the concrete base a height equal to the manufacturer's recommendations (leaving at least three threads exposed when secured).

A 5/8"x 12'0" copperweld ground rod shall be installed in each base as shown on the plans.

The Contractor shall design an anchor bolt assembly which shall be welded to the rebar cage and the resulting unit inserted in the form for the concrete base. The unit shall be designed and constructed such that, after insertion in the form, it can be checked for proper orientation, elevation and verticality. "Stabbing" of anchor bolts or ground rods will not be permitted.

The location of the bases shall be as shown on the plans. Any variation from the plan location shall be only with the approval of the Engineer.

Steel traffic signal pole bases shall be constructed in two pours. The initial concrete placement shall end six inches (6") below finish grade. A six inch (6") thick, thirty-six inch (36") square concrete cap shall be poured when the pole has been erected, plumbed, and approved by the Engineer. The top of the base shall be slightly (1/4" to 1/2") higher than the adjacent curb and gutter, or finish grade if no curb and gutter. Aluminum pedestal bases shall be constructed in one pour as detailed on the plans.

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SECTION 705

WIRING

705.1 GENERAL

Wiring shall conform to the appropriate articles of the National Electric Code or subsequent revisions. The conductors from the terminal block in the controller to the signal base shall be a continuous run. No splices of cable will be permitted in conduit or outside of junction boxes, service boxes or pole bases unless otherwise specified in the supplemental specifications, special provisions, or on the plans for an overhead wiring system. All signal cable splices shall be made above ground in pole or pedestal bases.

When conductors and cables are pulled into the conduit, all ends shall be taped to exclude moisture, and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall remain taped.

When pulling conductors through conduits, a powdered soapstone, talc or other approved lubricant shall be used. Cable shall not be taped or bundled together to be pulled or left in conduit.

Six feet (6') of slack or excess cable, as applicable, shall be left in each service box for traffic signal cable, communications cable, and detector lead-in wire.

Two feet (2') of slack or excess cable shall be left in each junction box and at each termination point.

Excess cable in service boxes and junction boxes to be uniformly bundled and secured with a conduit clamp of adequate size attached to side of box with 1/4" threaded stud bolt.

705.2 SPLICES

- a) Signal conductor cable - Conductors shall be joined by twisting the conductors. Conductor insulation shall be penciled, trimmed to conical shape, before applying splice insulation. Splice insulation shall consist of layers of thermoplastic or neoprene insulation electrical tape bearing the label of the Underwriters Laboratories, Inc., applied to a thickness equal to and well lapped over the original insulation, except that on high voltage splices two layers of rubber tape conforming to the requirements of ASTM D-119 shall be applied over the conductor before placing the thermoplastic tape. The splice shall then be well covered with two layers of friction or other approved tape. At least two feet (2') of slack shall be left for each cable splice in pedestal and pole bases.
- b) When terminating ends of cable at all terminal blocks an approved #14 insulated spade terminal shall be properly crimped on end of each conductor to provide a secure connection.
- c) Locking spade terminals shall not be used.

705.3 WIRING NOTES

- a) The Contractor shall furnish and install all loop wire, shielded loop lead-in wire, power supply cable and traffic signal cable for the complete operation of the traffic signal.

- b)** One seven conductor cable shall be run from the controller to each signal pole for pedestrian movement. The following color codes shall be used:

| | |
|---------------|----------------------------|
| Red | Don't Walk (Phase 2 or 6) |
| Green | Walk (Phase 2 or 6) |
| Orange | Push Button (Phase 2 or 6) |
| White w/Black | Don't Walk (Phase 4 or 8) |
| Blue | Walk (Phase 4 or 8) |
| Black | Push Button (Phase 4 or 8) |
| White | Common |

- c)** One five conductor cable shall be run from the pole base to each 3-section signal head. The following color codes shall be used:

| | |
|--------|-------------|
| Black | Not Used |
| White | Common |
| Red | Red Ball |
| Green | Green Ball |
| Orange | Yellow Ball |

- d)** One seven conductor cable per conflicting movement shall be run from the controller to each signal pole. The following color codes shall be used:

| | |
|---------------|-------------------------------------|
| White | Common |
| Red | Red Ball |
| Green | Green Ball |
| Orange | Yellow Ball |
| Blue | Green Arrow |
| Black | Yellow Arrow |
| White w/Black | Street Name Sign (where applicable) |

- e)** Each signal head mounted on a signal pole or mast arm shall have one continuous multi-conductor cable run from the pole base to the signal head. A five-section signal head (left turn signal) shall have a seven conductor cable. A three-section signal head (through movement) shall have a five-conductor cable. Pedestrian signal heads shall have a five conductor cable. Each pushbutton shall have a two-conductor cable.

- f)** A single conductor stranded No. 8 green wire shall carry the equipment ground from the grounding lug of all signal poles, pedestals, controller cabinet and the power disconnect box.

- g)** One five conductor cable shall be run from the pole base to pedestrian signal head. The following color codes shall be used:

| | |
|--------|---------------------------|
| White | Common (All Phases) |
| Red | Don't Walk (Phase 2 or 6) |
| Green | Walk (Phase 2 or 6) |
| Orange | Don't Walk (Phase 4 or 8) |
| Black | Walk (Phase 4 or 8) |

- h)** Identify cable runs in cabinet.

SECTION 706

CABINET WIRING AND CABLE IDENTIFICATION

706.1 CABINET WIRING

The following is the standard City of Wichita specifications for wiring and labeling cables in a 332 cabinet and shall be closely followed, any deviation from these specifications must be approved by the Engineer or his representative:

- a) All cables shall have adequate excess cable at the termination ends so there is no tension on the conductors.

Traffic signal cables shall be five (5) feet in length and stripped back three (3) feet.

Pedestrian signal cables shall be the same as the signal cables except the push button conductors shall be seven (7) feet in length to reach the proper termination point without the use of a butt splice.

Detector feeder cable shall be eight (8) feet in length and stripped back eight (8) inches.

- b) The cables shall be formed in such a manner so that any access panels can be lowered without interference.
- c) There shall not be any use of tape on the stripped out conductors.
- d) Nylon-cable ties shall not be used on any field cables except those used for identification.
- e) The drain wire of each detector feeder shall be covered with a tube type covering (i.e., shrink tube) not more than three (3) times the diameter of the wire.
- f) All cable fillers shall be removed from stripped back cable.
- g) Each conductor shall be separately terminated with a non-locking, insulated block fork terminal of the appropriate size.
- h) All conduits entering the cabinet base shall be closed with an approved duct seal.
- i) All excess cable shall be neatly formed in the bottom of the cabinet.
- j) All cables terminating at the input files shall be run in the provided pan ducts.
- k) All traffic and pedestrian signal cables, also detector feeders, shall be permanently and legibly identified by the use of Nylon Identification Cable Ties. Traffic signal and pedestrian signal cables shall have a marking pad size of ½ inch x 7/8 inches (i.e., TY-RAP #TY546M). Detector feeders shall have a marking pad size of 1 inch x 5/16 inches (i.e., TYP-RAP #TY551M). The legends shall be made with a permanent type marking pen.

The following legends shall be used for traffic signal and pedestrian signal cables:

| | |
|------------|--|
| "NW Sigs." | = Traffic signal cable to NW corner |
| "NW Peds." | = Pedestrian signal cable to NW corner |
| "NE Sigs." | = Traffic signal cable to NE corner |
| "NE Peds." | = Pedestrian signal cable to NE corner |
| "SW Sigs." | = Traffic signal cable to SW corner |
| "SW Peds." | = Pedestrian signal cable to SW corner |
| "SE Sigs." | = Traffic signal cable to SE corner |
| "SE Peds." | = Pedestrian signal cable to SE corner |

The following legends shall be used for detector feeders:

| | |
|--------------|--|
| "WBLT" | = Phase 1 Westbound Left Turn Loop |
| "EB FAR" | = Phase 2 Eastbound Far Advance Loop |
| "EB MID" | = Phase 2 Eastbound Middle Advance Loop |
| "EB CLOSE" | = Phase 2 Eastbound Close Loop |
| "EB RT. LN." | = Phase 2 Eastbound Right Lane Loop (If Applicable) |
| "EB LT. LN." | = Phase 2 Eastbound Left Lane Loop (If Applicable) |
| "SBLT" | = Phase 3 Southbound Left Turn Loop |
| "NB FAR" | = Phase 4 Northbound Far Advance Loop |
| "NB MID" | = Phase 4 Northbound Middle Advance Loop |
| "NB CLOSE" | = Phase 4 Northbound Close Loop |
| "NB RT. LN." | = Phase 4 Northbound Right Lane Loop (If Applicable) |
| "NB LT. LN." | = Phase 4 Northbound Left Lane Loop (If Applicable) |
| "EBLT" | = Phase 5 Eastbound Left Turn |
| "WB FAR" | = Phase 6 Westbound Far Advance Loop |
| "WB MID" | = Phase 6 Westbound Middle Advance Loop |
| "WB CLOSE" | = Phase 6 Westbound Close Loop |
| "WB RT. LN." | = Phase 6 Westbound Right Lane Loop (If Applicable) |
| "WB LT. LN." | = Phase 6 Westbound Left Lane Loop (If Applicable) |
| "NBLT" | = Phase 7 Northbound Left Turn Loop |
| "SB FAR" | = Phase 8 Southbound Far Advance Loop |
| "SB MID" | = Phase 8 Southbound Middle Advance Loop |
| "SB CLOSE" | = Phase 8 Southbound Close Loop |
| "SB RT. LN." | = Phase 8 Southbound Right Lane Loop (If Applicable) |
| "SB LT. LN." | = Phase 8 Southbound Left Lane Loop (If Applicable) |

- I) The traffic signal and pedestrian signal field wires shall terminate at the following locations in all 332 cabinets:

| | |
|----------|----------------------------------|
| WBLT | - RED 125, YELLOW 126, GREEN 127 |
| EB SIGS. | - RED 128, YELLOW 129, GREEN 130 |
| EB PEDS. | - DW 113, WALK 115 |
| SBLT | - RED 116, YELLOW 117, GREEN 118 |
| NB SIGS. | - RED 101, YELLOW 102, GREEN 103 |
| NB PEDS. | - DW 104, WALK 106 |
| EBLT | - RED 131, YELLOW 132, GREEN 133 |
| WB SIGS. | - RED 134, YELLOW 135, GREEN 136 |
| WB PEDS. | - DW 119, WALK 121 |
| NBLT | - RED 122, YELLOW 123, GREEN 124 |
| SB SIGS. | - RED 107, YELLOW 108, GREEN 109 |
| SB PEDS. | - DW 110, WALK 112 |

- m)** The detector feeders and the pedestrian pushbutton field wires shall terminate at the following locations in all 332 cabinets:

- 1.** Detector Feeders
WBLT - I-1-DE
EB FAR ADV - I-2-DE
EB MID ADV - I-2-JK
EB CLOSE - I-3-DE
SBLT - I-5-DE
NB FAR - I-6-DE
NB MID - I-6-JK
NB CLOSE - I-7-DE
EBLT - J-1-DE
WB FAR - J-2-DE
WB MID - J-2-JK
WB CLOSE - J-3-DE
NBLT - J-5-DE
SB FAR - J-6-DE
SB MID - J-6-JK
SB CLOSE - J-7-DE

All drain wires to terminate at terminal L of the corresponding slot.

- 2.** Pedestrian Pushbuttons
EB PEDS. - I-12-D
NB PEDS. - I-12-J
WB PEDS. - I-13-D
SB PEDS. - I-13-J

- n)** If any additional loop or field wire terminations are necessary, their location will be determined by the Engineer or his representative.

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SECTION 707

MAST ARM AND POLE BASE CABLE IDENTIFICATION

The following is the specification for identifying all cables used in the complete operation of the traffic signals which are located in mast arms and pole bases.

The through traffic and pedestrian signal cables shall be legibly identified with the use of Nylon Identification Cable Ties. The marking pad size shall be ½ inch x 7/8 inches (i.e., TY-RAP #TY546M). The legend shall be made with a permanent type marking pen.

The pushbutton cables shall be legibly identified with the use of Nylon Identification Cable Ties. The marking pad size shall be 1 inch x 5/16 inches (i.e., TY-RAP #TY551M). The legends shall be made with a permanent type marking pen.

Mast Arm Traffic and Pedestrian Signal Cable Legends

a) Mast Arm Signal Cables

- "Lt. Turn Sig." - Left Turn Signal
- "Out Bd. Sig." - Farthest Through Traffic Signal from Pole
- "Center Sig." - Next Farthest Through Traffic Signal from Pole (If Applicable)
- "In Bd. Sig." - Closest Thru Traffic Signal to Pole
- "SOP Sig." - Side of Pole Through Traffic Signal

b) Pole Mounted Pedestrian Signals and Pushbuttons

- "Ped. Sig." - Pedestrian Signal
- "Ph.2 P.B." - All Phase 2 Pushbuttons
- "Ph.4 P.B." - All Phase 4 Pushbuttons
- "Ph.6 P.B." - All Phase 6 Pushbuttons
- "Ph.8 P.B." - All Phase 8 Pushbuttons

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SECTION 708

TRAFFIC SIGNAL HEADS

Traffic signal heads, shown on the signalization plan sheets, mounted on the side of poles or on pedestals shall be ten feet (10') from the ground to the bottom of the signal head.

Type II side-of-pole pedestrian signal bracket to be mounted on back side of pole 135° clockwise from mast arm.

Traffic signal heads mounted on mast arms or span wire shall be no less than sixteen feet (16') and no more than nineteen feet (19') from the pavement to the bottom of the signal head. In some instances the Engineer may require the signal to be mounted above sixteen feet (16') for better visibility. Under no circumstances shall the bottom of the signal be more than nineteen feet (19') above the pavement.

The Engineer shall direct the final positioning of the signal heads. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

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SECTION 709

POLE INSTALLATION

When installed, the traffic signal poles shall be back raked according to the manufacturer's recommendation to allow for deflection, such that the pole will be plumb when loaded.

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SECTION 710

LOOP DETECTOR INSTALLATION

The field loop conductor installed in the pavement shall run continuously from the terminating service box, junction box, or base with no splices permitted. The field loop conductors shall be spliced to the lead-in cable and the lead-in cable shall run continuously from the terminating service box, junction box, or base to the sensing unit, except on multiple loop installations where additional loop conductors may be spliced to the lead-in cable as directed by the Engineer.

All lengths of loop wires that are not embedded in the pavement shall be twisted with at least two (2) turns per foot, including lengths in conduits and handholes.

The electrical splice between the loop lead-in cable to the controller and the loop wire shall be made by the following method:

- a) Remove all lead-in cable coverings and ground wire, leaving four (4) inches of insulated wire exposed.
- b) Remove the insulation from each conductor of the lead-in cable and scrape both copper conductors with knife until bright.
- c) Remove appropriate length of insulation from the ends of the loop wires and scrape both copper conductors with knife until bright.
- d) Conductors shall be joined by using a #14 butt splice. The two splices shall be staggered to provide adequate insulation. Each splice shall be insulated with layers of thermoplastic or neoprene insulation electrical tape bearing the label of the Underwriters Laboratories, Inc., applied to a thickness equal to and well looped over the original insulation.

The two splices shall then be over-wrapped with layers of thermoplastic or neoprene insulation as above and then coated thoroughly with a water proof electrical coating.

The location of each loop shall be marked on the pavement with crayon or spray paint. The Contractor shall obtain the approval of the Engineer prior to cutting the saw slots.

The saw shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. The blade used for the saw cut shall provide a clean, straight, well-defined one-fourth (1/4) inch wide saw cut without damage to adjacent areas. The depth of the saw cut shall be 3 ½ inches deep. Where the loop changes direction, the saw cuts shall be overlapped to provide full depth at all corners. Right angle or corners less than 90° shall not be used.

Before installing the loop wire, the saw cuts shall be checked for the presence of jagged edges or protrusions. Should these exist, they must be removed. The slots must be cleaned and dried to remove cutting dust, grit, oil, moisture or other contaminants. Cleaning shall be achieved by flushing clean with a stream of water, and following this, the slots should be cleared of water and dried using oil-free compressed air.

Loop detector conductor shall be installed using a one-eighth (1/8) inch to three-sixteenth (3/16) inch thick wood paddle.

Each loop shall be coiled clockwise (or per manufacturer's recommended practice) and the beginning conductor banded in the terminating handhole or base with a symbol "S" to denote start of conductor. Each loop shall be further identified by phase or function as shown on the project plans, with durable tags, or as directed by the Engineer.

3M Micro-Loops will be accepted in lieu of wire wound loops (excluding presence type loops) for close loops (2 required per lane), center and far advance loops (1 required per lane). Placement in lanes shall be according to manufacturer's recommendation. Microloop lead-in (home run) cables to be 3-M type CC30003, twisted, shielded, waterblock cable.

Each loop spliced to lead-in cable, checked at control cabinet, shall not measure less than 100 megohms to ground.

The Contractor shall supply the City of Wichita with a typed record of loop inductance and resistance to ground of each loop measured at cabinet along with the date each loop was checked.

710.1 RECOMMENDED MICROLOOP INSTALLATION GUIDELINES

- a) Before installing the microloop probe, a magnetic field strength and a magnetic field noise measurement shall be taken at the location of installation shown on the project plans. The readings must fall within the prescribed limits set by the manufacturer or their representative. If measurements as determined by engineer exceed specified limits, appropriate measures shall be taken to bring them within operational limits per manufacturer's specifications. If manufacturer's specified limits cannot be met, a standard inductance loop, as determined by engineer, shall be installed in lieu of microloop.
- b) Make a sawcut from the curb to the furthest most probe location and remove any water from cut. Bore a 1 ½" hole 18" below the 1/4" by 3 ½" deep sawcut at determined probe location(s) for insertion of a 1" PVC conduit. The conduit shall be cut to an 18" length and bottom cap installed (1" plastic "push penny" plug, i.e., T&B #1472).
- c) If when installing two or more probes in a set, and there is excess cable between probes, a hole of sufficient depth shall be bored between the probes and the excess cable be inserted into the hole. Fine dry sand, such as sandblasting sand, or other material approved by the engineer should be used to fill the holes and conduit to the bottom of the saw cut. Any excess area around the conduit should also be filled.
- d) Before beginning permanent installation, resistance checks shall be made with an ohmmeter. Readings shall be in accordance with manufacturer's expected readings. Also a reading shall be taken with a megohmmeter to insure that resistance to ground is greater than 100 megohms. These checks shall be made before the permanent splice is made and taken at the cabinet before termination. An approved sealant shall then be used to fill the sawcut.

SECTION 711

COMMUNICATIONS CABLE

711.1 SPLICES GENERAL

Communications cable splices shall be made at the communications terminal block within the signal controller cabinet whenever possible. Other necessary cable splices shall be made only with approval of the project engineer in the manner dictated below.

711.2 UNDERGROUND SPLICES

Underground communications cable splices shall be made only within service boxes or utility manholes using an approved waterproof, re-enterable splice kit with multiple port and caps if necessary. The splices shall be staggered heat shrinkable insulated butt splices. The splice kits shall be filled with an approved non-hardening, waterproof encapsulant (3-M Type 4442 Gella or equivalent). The enclosure shall be transparent and capable of being racked in the service box or manhole immediately after filling with encapsulant. The contractor shall rack all splice kits after filling with encapsulant.

711.3 AERIAL SPLICES

Aerial splices shall be made using a Reliance COM/TECH #100 MBK aerial closure kit with #1648-P terminal blocks or equivalent. Reliance COM/TECH #170 "Y" or equivalent branch kits shall be used when two communications cables enter the aerial splice from one side. Communications cable shall be secured to the messenger cable 6" - 12" from the aerial closure with lashing wire or black, weather resistant tie wraps.

711.4 SHIELD GROUNDING

Communications cable shielding shall be grounded at one point only - at the control center in City Hall for CBD zones and at the on-street master cabinet for non-CBD zones. Shielding at all splice points (aerial, underground or at the controller cabinet) shall be connected together using 3-M #4460-S or equivalent shield connectors and a #14 THNN stranded, white insulated wire with a ring tongue connector on each end as a bonding jumper between the shield connectors. Proper insulation (Scott 33+ or equivalent) shall be used on all bare parts of the bonding system to prevent contact with the messenger cable or other metal parts in the closure.

711.5 TESTING

A continuity test and an insulation resistance test of each communications pair (including spares) will be conducted in the presence of the project engineer or his representative. During the tests, all transient suppression devices shall be disconnected. If any test fails, repairs shall be made by the contractor and the entire test for that cable circuit shall be repeated.

711.6 CONTINUITY TEST

The continuity test shall be made between a point upstream of where the new communications cable is spliced to the existing cable and each new field termination point. Each conductor in a pair shall show a resistance of not more than 10 ohms per 1,000 feet of AWG #19 conductors. The resistance shall be measured with a meter having a minimum resistance of 20,000 ohms/ volt. The Contractor shall supply the City of Wichita with a typed record of the resistance of each paired conductor.

711.7 INSULATION RESISTANCE TEST

The insulation resistance test shall be measured with all other connections to the conductor under test removed, and all other conductors in the cable and the shield grounded. The measurement shall be made with a direct current potential of not less than 360 volts nor more than 550 volts applied for one minute. Insulation resistance shall exceed 5,000 megohm-mile. The Contractor to supply City of Wichita with typed record of the resistance of each conductor.

SECTION 712

MESSENGER CABLE

Where shown in the plans, the messenger cable shall be used to support all overhead communications and detector lead-in cable. The messenger cable shall be 5/16 inches in diameter and shall include devices such as rings or spiral slashing used to attach the cable, and shall run from structure to structure without splicing. Prior to erecting messenger cable, the contractor shall determine the length of the strand required to span the distance between the poles indicated on the drawings, allowing a sufficient additional length of span wire to compensate for sag.

No messenger cables shall be erected which would lie on, or are liable to run on, a utility company wire or cable, tree limb, etc. If a messenger cable is erected within 12 inches of any other cable, wire or structure, it shall be protected with plastic wire guards. The height of the messenger cable on the pole shall conform to requirements of the serving utility and the National Electrical Code, and the National Electric Safety Code.

SECTION 713

SERVICE AND JUNCTION BOXES

Installation of service and junction boxes shall be in accordance with the plans and detail sheets.

SECTION 714

SIGNS

Installation of signs shall be in accordance with the plans and detail sheets.

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